BIOLOGICAL WARFARE AGENTS, TOXINS, VECTORS AND PESTS AS BIOLOGICAL TERRORISM AGENTS

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ABSTRACT

The threat and use of biological agents for warfare and terrorism purposes has a long history. As the human, animal and plant pathogens and toxin lists will be hard to define we propose several tables of enlisted pathogens and toxins with important criteria on the basis of which a decision can be made to include in or exclude from a list of biological agents and toxins. Human, animal and plant pathogens as a biological terrorism or warfare agents have the capacity to cause disease and potentially be used to threaten humans, animals and staple crops. From a social-economic and significant adverse human health impacts, human, animal and plant pathogens must be evaluated and prioritized. This paper describes of evaluation of human, animal and plant pathogens and toxins as terrorism agents and can serve as the basis for scientific discussion and as help on defining the list of terrorism biological agents and toxins. This paper also discuses and shows the main vectors that can be used as a terrorism delivery system or biological agents in hostile activities. The main pests that include the invertebrates such as insects and arthropods with potential terrorism and military use are presented.

INTRODUCTION

Many biological agents have the capacity to cause disease and potentially be used to threaten civilian populations. The purpose of this paper is to provide information on biological agents and toxins to military and health-care providers at all levels to help them make informed decisions on protecting from these agents. Although the use of biological agents and toxins in military conflicts has been a concern of military communities for many years, several recent events have increased the awareness regarding the potential use of these weapons by terrorists against civilian populations.

High level of dissemination is criterion we used in evaluation of human pathogens and toxins. The key for producing large-scale respiratory infections is to generate an aerosol of suspended microscopic droplets, each containing one to thousands of bacterial or virus particles. High level of dissemination or large-scale contamination or cover a large area as aerosol for respiratory exposure plays the main role in evaluation of particular agent or toxin.

In the tables, the plus signs (+) signify that pathogen or toxin satisfies the particular criterion for inclusion in the list. At the same time the minus signs (-) signify that pathogen or toxin does not satisfy criterion for inclusion in the list. In the column: Totals, you can see a number of positive answers.

According to criterion, no effective prophylaxis or therapy, positive answer signifies the absence of effective prophylaxis and medical treatment. The existence of immunization and appropriate treatment against a particular agent is in inverse proportion to the likelihood that the agent will be used. There are not effective prophylaxis and therapy against for the bulk of enlisted agents and toxins if used as biological and toxin warfare agents. For full series of vaccination takes at least three months and in same cases up to one year. Because of that it is difficult to imagine how it would be looked like mass-vaccination often maybe simultaneously against more than one disease.

Toxins are effective and specific poisons produced by living organisms. They usually consist of an amino acid chain, which can vary in molecular weight between a couple of hundred (peptides) and one hundred thousand (proteins). They may also be low-molecular organic compounds. Numerous

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organisms, e.g., bacteria, fungi, algae and plants, produce toxins. Many of them are extremely poisonous, with a toxicity that is several orders of magnitude greater than the nerve agents.

Research literature suggests that we have discovered the majority of the "most toxic" (LD_{50} < 0.0025 mg/kg) naturally occurring toxins. Because they must be delivered as respirable aerosols, their toxicities and ease of production limit toxins' utility as effective Mass Casualty Biological (toxin) Weapon (MCBW).

Toxins poisonous substance produced by the metabolic activities of certain living organisms, including bacteria, insects, plants, and reptiles. Toxins are still considered to be less suitable for dispersal on a large scale. Nonetheless, they could be used for sabotage or in especially designed inputs, e.g., against key persons. Since toxins have low volatility, they are dispersed as aerosols and then taken up foremost through inhalation. The new micro-encapsulation technology, which is easy to use, makes it possible to protect unstable toxins when dispersed.

Fifteen to twenty of some 400 known toxins have the physical characteristics that make them threats against military forces as potential MCBWs. However, many toxins could be used in weapons to produce militarily significant/terrorist (psychological) effects-especially in poorly educated civilian populations.

There are still many unknowns regarding toxins and their weaponization. Toxin is any toxic substance that can be produced by an animal, plant or microbe. Some toxins can also be produced by molecular biologic techniques (protein toxins) or by chemical synthesis (low molecular weight toxins). A Mass Casualty Biological (toxin) Weapon (MCBW) is any toxin weapon capable of causing death or disease on a large scale, such that the military or civilian infrastructure of the state or organization being attacked is overwhelmed. A militarily significant (or terrorist) weapon is any weapon capable of affecting-directly or indirectly, physically or through psychological impact-the outcome of a military operation.

From a public health standpoint, human, animal, plant pathogens and toxins must be evaluated and prioritized in order to assure appropriate allocation of the limited funding and resources that are often found within public health systems.

Potential terrorism and warfare biological agents and toxins were given with an expected mortality of ≥50% were rated higher (+++) than agents with lower expected mortalities (21-49% = ++, and <21% = +).

Biological agents and toxins with higher rating (++) for morbidity are if clinical disease required hospitalization for treatment (including supportive care), and with lower rating (+) if outpatient treatment was possible for most cases.

Biological agents and toxins received + to +++ for dissemination potential based on their likely methods of contamination a large area by aerosol for respiratory exposure (+++), on contamination in quantities that could affect large populations (++), and sabotage on food and water supply (+).

High level of infectivity or intoxication by variety route is showed according of the kind of exposure: direct contact (+), respiratory route (++), or both (+++).

Biological agents and toxins also were ranked based on any special public health preparedness that was required including: stockpiling of therapeutics (+), enhanced surveillance and education (+), and improved laboratory diagnostics (+).

Public fear associated with an agent and the potential mass civil disruptions that may be associated with even a few cases of disease were also considered (+ to +++).

The additional list of criteria for toxins and table of toxins should be used for more detailed risk assessment and for comparison of the toxins on the list in which the lower the total number, the more dangerous toxin as terrorism or warfare agent, and with the purpose of making final decision on the list of toxins easier. In the additional list of criteria for toxins, it can be seen at a glance unimportant criterion: Ease of decontamination. For toxins, decontamination would be relatively unimportant but fungal toxins are extremely difficult to decontaminate and once an area is contaminated (infected), it can take years of hard cleaning to get rid of the toxins, especially if delivered with fungal spores.

For the evaluation of toxins, the toxicity should be interpreted with caution and certainly should include agents that are non-lethal but military and terrorism incapacity. Lethality alone is not appropriate criterion on which to base toxin's potential. For evaluation of toxins it was preferred toxins that cause primarily incapacitating to lethal toxins because these toxins have high potency and they represent a significant treat in the future. For example Staphylococcal enterotoxin B (SEB), so-called super antigen

is one the most potent agents for incapacitating can cause illness at extremely low doses but relatively high doses are required to kill. In this group of enlisted toxins can be included Trichotecene-Mycotoxins, Batrachotoxin and Brevetoxin. In inverse case when it would be preferred lethality to incapacity, toxins for incapacitating would be underestimated.

The criteria that used for evaluation of animal and plant pathogens, vectors and pests was compiled from several sources: criteria for selection of biological agents used for negotiations in Ad-hoc Group of states-parties of BTWC, the Australia Group, the Centers for Disease Control and Prevention, Food and Agriculture Organization (FAO) and International Office of Epizootics (OIE). Rankings of animal and plant pathogens, vectors and pests as potential warfare and bioterrorism agents are shown in tables. As a result of this evaluation paper finally presents lists of animal and plant pathogens, vectors and pests as warfare and terrorism agents.

Criteria for selection of human pathogens and toxins as terrorism agents

1. High level of morbidity: higher rating (++) if clinical disease requires hospitalization for treatment including supportive care and lower rating (+) if outpatient treatment is possible for most cases.
2. High level of mortality or incapacity: agents with an expected mortality of ≥50% were rated higher (+++), and with lower expected mortalities (21-49%=++, and <21%=+).
3. Stability in the environment after release (+).
4. Ease of production and transportation (+).
5. Likely methods for terrorism usage and high level of dissemination or contamination by aerosol for respiratory exposure (+++), contamination in quantities that could affect large populations (++), and dissemination potential for sabotage on food and water supply (+).
6. High potency: effective dose (ED_{50}) for biological agents or pathogens (0.1 – 15 PFU- plaque forming unit intracerebral, intraperitoneal, aerogenic or hypodermic for viruses) and (1 – 100 organisms for bacteria) (+++). For toxins: LD_{50} <0,000025 mg/kg (+++), LD_{50} from 0,000025 to 0,0025 mg/kg (++) and LD_{50} >0,0025 mg/kg (+).
7. High level of contiguousness/transmissibility or infectiousness/intoxication by variety route: direct contact (+), respiratory route (++), or both (+++).
8. No effective prophylaxis and antidotal therapy (+).
9. Special public health preparedness (+++) that requires including: stockpiling of therapeutics (+), enhanced surveillance and education (+), and improved laboratory diagnostics (+).
10. Difficult to diagnose or identify at the early stage (+).
11. Public perception: Public fear associated with an agent and the potential mass civil disruptions that may be associated with even a few cases of disease were also considered (+ to +++).

Human pathogens (viruses) as biological terrorism agents:

1. Variola major virus (Smallpox virus)
2. Lassa fever virus
3. Ebola virus
4. Marburg virus
5. Crimean-Congo hemorrhagic fever virus
6. Machupo virus
7. Rift Valley fever virus
8. Monkeypox virus
9. Sin Nombre virus
10. Junin virus
11. Tick-borne encephalitis virus
12. Eastern equine encephalitis virus
13. Western equine encephalitis virus
14. Venezuelan equine encephalitis virus
15. Yellow fever virus
16. Hantaan virus
17. Nipah virus
18. Chikun-Gunya fever virus (CHIK)

19. Dengue fever virus
20. Omsk fever virus

Human pathogens (bacteria, rickettsiae, protozoa and fungi) as biological terrorism agents:
Bacteria/Rickettsia
1. Bacillus anthracis
2. Yersinia pestis
3. Francisella tularensis
4. Rickettsia prowazekii
5. Rickettsia rickettsii
6. Bulkholderia (Pseudomonas) mallei
7. Bulkholderia (Pseudomonas) pseudomallei
8. Bulkholderia (Pseudomonas) pseudomallei
9. Brucella melitensis
10. Coxiella burnetti
11. Brucella abortus
12. Brucella suis
13. Chlamydia psittaci
Protozoa
1. Naegleria fowleri
2. Naegleria australiensis
Fungi
1. Nocardia asteroides
2. Coccidioides immitis
3. Histoplasma capsulatum

Additional criteria for selection of toxins
(The lower the total number means the more dangerous the toxin as warfare and terrorism agent)
1. ***Toxicity***
1= Lethal dose (LD_{50}) in the 10^{-9}g/kg range.
10= Lethal dose (LD_{50}) in the 10^{-3}g/kg range.
2. ***Level of incapacity or mortality***
1= Predominately cause incapacitating.
10= Predominantly lethal.
3. ***Likely methods of dissemination***
1= Toxin could be aerosolized and delivered to cover large areas for aerosol contamination (large-scale dissemination). Toxin could be used in sabotage for contamination food and water.
10= Toxin could not be aerosolized and delivered to cover large areas for aerosol contamination. Toxin could be difficult used in sabotage.
4. ***Stability in environment/storage***
1= Extremely stable in storage and environment.
10= Unstable in environment or requires special storage conditions.
5. ***Onset***
1= Minutes or hours to onset.
10= Hours or days to onset.
6. ***Ease of decontamination***
1= Extremely difficult to decontaminate after a toxin aerosol attack.
10= Decontamination would be relatively unimportant and general decontamination procedures effectively destroy toxin.
7. ***Ease of production and transportation***
1= Toxin can be ease produced in large quantities - low technology, low cost, widely available (fermentation).
10= Toxin that is very difficult to produce in weaponizable quantities - high cost, only available to specialized teams (solid phase synthesis of >100 amino acid polypeptides, advanced genetic manipulation).

Toxins as terrorism agents:

1. Botulinum toxin
2. Ricin
3. Staphylococcal enterotoxin B (SEB)
4. Shigatoxin
5. Saxitoxin
6. Abrin
7. Trichotecene Mycotoxins (T2, DON, HT2)
8. Anatoxin A
9. Modeccin
10. Tetrodotoxin
11. Centruroides toxin
12. Toxin of Clostridium perfrigens
13. Ciguatoxin
14. Brevetoxin
15. Palytoxin
16. Cyanginosin/Microcystin
17. Batrachotoxin
18. Bungarotoxin
19. Aflatoxin
20. Viscumin
21. Viscumin
22. Volkensin

Criteria for selection of animal pathogens as biological terrorism agents

1. Agents which have severe socio-economic and/or significant adverse human health impacts (+).
2. High morbidity and/or mortality rates: agents with an expected mortality of ≥50% were rated higher (+++), and with lower expected mortalities (21-49%=++, and <21%=+).
3. Short incubation period (+).
4. High transmissibility and/or contiguousness high level of infectiousness/intoxication by contact (+), by respiratory route (++), or both (+++).
5. Low infective/toxic dose (+).
6. Difficult to diagnose/identify at an early stage (+).
7. Stability in the environment (+).
8. Lack of availability of cost effective protection / treatment (+).
9. Ease of production (+).

Animal pathogens as biological terrorism agents:

Viruses

1. African swine fever virus
2. Avian influenza virus (Fowl plague virus)
3. Vesicular stomatitis virus
4. Classical swine fever virus (Hog cholera virus)
5. Classical swine fever virus (Hog cholera virus)
6. Newcastle disease virus
7. Rinderpest virus
8. Pest des petits ruminants virus
9. Bluetongue virus
10. Teschen disease virus (Porcine enterovirus type 1)
11. Rift Valley fever virus
12. Nipah swine encephalitis virus
13. African horse sickness virus
14. Camel pox virus
15. Lumpy skin disease virus

Bacteria

1. Bacillus anthracis
2. Bulkholderia (Pseudomonas) mallei
3. Brucella spp.

Mycoplasmas

1. Contagious bovine (pleuropneum.) (M. mycoides var. mycoides type SC) (CBPP)
2. Contagious caprine (pleuropneum.) (M. capriculum var. capri pneumoniae type F38) (CCPP)

Criteria for selection of plant pathogens as biological terrorism agents

1. Agents which have severe socio-economic and/or significant adverse human health impacts, due to their effect on staple crops (+).
2. Short incubation period (+).
3. Ease of dissemination: by wind (+++), by insects (++), water, etc.(+).
4. Short life cycle (+)
5. Low infective dose (+).
6. Difficult to diagnose/identify at an early stage (+).
7. Stability in the environment (+).
8. High infectivity and causes severe crop losses: ≥60% (+++), 21-59% (++), and <21%(+).
9. Lack of availability of cost effective protection/treatment (+).
10. Ease of production (+).

Plant pathogens as biological terrorism agents:

Fungi

1. Colletotrichum coffeanum var. virulans
2. Puccinia graminis (Stem Rust, Black Rust)
3. Tilletia indica (Carnal Bunt)
4. Sclerotinia sclerotiorum (Sclerotinia Stem Rot)
5. Dothistroma pini (Scirrhia pini) (Pine Needle Casts and Blights)
6. Puccinia striiformis (P. glumarum) (Stripe Rust, Yellow Rust)
7. Pyricularia oryzae (Rice Blast)
8. Ustilago maydis (Corn Smut)
9. Claviceps purpurea (Ergot)
10. Peronospora hyoscyami de Bary f.sp. tabacina (Adam) skalicky (Downy mildew)

Bacteria

1. Xsanthomonas albilineans (Leaf Scald)
2. Erwinia amylovora (Shoot Blight)
3. Ralstonia solanacearum (Bacterial Wilt)
4. Xsanthomonas campestris pv. citri (Citrus Cancer)
5. Xsanthomonas campestris pv. oryzae (Rice Bacterial Leaf)

Viruses

1. Sugar cane Fiji disease virus (Sugar cane Fiji disease)

Criteria for selection of vectors or carriers as biological terrorism and warfare agents

1. Vectors known to have been produced, used or alleged to be used as weapons (+).
2. Vectors which cause significant impact on human health or animal resources (+).
3. Short life cycle (+).
4. Ease of production (+).
5. Resistance to insecticides or bio control agents (+).
6. Ease of dissemination (+).

Vectors as terrorism and warfare agents:

1. Xenopsylla spp.
2. Ctenocephalis spp.
3. Leptopsilla spp.
4. Hyalomma marginatum

5. Hyalomma Anatolicum Anatolicum
6. Dermacentor spp.
7. Rhipicephalus spp.
8. Amblyomma spp.
9. Mansonia spp.
10. Culex spp.
11. Culiseta spp.
12. Pediculus humanus
13. Dermacentor andersoni
14. Dermacentor varabilis
15. Amblyimma Cajennese
16. Rhipicephalus sanguineus

Criteria for selection of pests as biological terrorism and warfare agents

1. Pests known to have been produced, used or alleged to be used as weapons (+)
2. Pests which cause sever socio-economic and/or significant adverse effect to plants (+).
3. Ease of production (+).
4. Short life cycle (+).
5. Resistance to pesticides (+).
6. High reproducibility (+).
7. Ease of dissemination (+).

Pests as terrorism and warfare agents:

1. Dociostaurus maroccanus
2. Haplothrips Tritici
3. Thrips Tabaci
4. Eurygaster integriceps
5. Lygus linecularus
6. Acrosternum milleri
7. Chilo suppressalis
8. Cirphis unipunctata
9. Earias insulana
10. Leptinotarsa decemlineata (Colorado potato beetle)
11. Harmolita tritici
12. Phytophaya destructor
13. Terranychus takestani
14. Cenopalpus spp.
15. Diabrotica virgifera virgifera

As the list of bioregulators and toxins will be hard to define for purposes of the future negotiations of the States Parties of BTWC, this paper proposes six tables of enlisted human, animal and plant pathogens and toxins with important criteria on the basis of which a decision can be made to include in or exclude from a list of the biological agents and toxins. Rankings of potential biological agents and toxins according to important criteria are shown in:

Table 1a. Human pathogens (viruses) assessment according to criteria for selecting pathogens as biological terrorism agents.

Table 1b. Human pathogens (bacteria, rickettsiae, protozoa and fungi) assessment according to criteria for selecting pathogens as biological terrorism agents.

Table 2a. Toxin assessment according to criteria for selecting toxins as terrorism agents.

Table 2b. Toxin Risk Assessment (the lower the total number means the more dangerous the toxin as warfare and terrorism agent).

Table 3. Animal pathogens assessment according to criteria for selecting pathogens as terrorism and warfare agents.

Table 4. Plant pathogens assessment according to criteria for selecting pathogens as terrorism and warfare agents.

Table 5. Vectors assessment according to criteria for selecting as terrorism and warfare agents.

Table 6. Pests assessment according to criteria for selecting as terrorism and warfare agents.

CONCLUSIONS

All of that shows that it is very hard to make a final decision on criteria and the final list of the molecular agents (bioregulators) for the needs of future Protocol to the BTWC based on these criteria. Because of all of that, this paper proposes that list and criteria for bioregulators be well studied and that an opinion by scientists and experts be obtained, because the list should be scientifically based. Although many bioregulators can be used to cause illness, they can truly threaten civilian populations on a large scale. If released upon a civilian population, these agents would pose the most significant challenge for public health and medical responses.

Although many biological agents such as toxins and bioregulators can be used to cause illness, there are only a few that can truly threaten civilian populations on a large scale. If released upon a civilian population, these agents would pose the most significant challenge for public health and medical responses. The above criteria for ranking potential toxins and bioregulators and listing of them of greatest public health concern could be used for determination of priority biological threat agents for national public health preparedness efforts for bioterrorism. Having a defined method for evaluating biological threat agents allows for a more objective evaluation of newly emerging potential threat agents, as well as continued re-evaluation of established threat agents. Using this prioritization method can help focus public health activities related to bioterrorism detection and response and assist with the allocation of limited public health resources.

Many animal and plant pathogens, vectors and pests can be used as terrorism and warfare biological agents and cause illness. Transmissible animal diseases classified under A and B List have the potential for very serious and rapid spread, irrespective of national borders which are of serious socio-economic or public health consequence and which are of major importance in the international trade of animals and animal products. Those transboundary animal diseases are of significant economic, trade and security importance. Having a defined and good method for evaluating biological threat agents such as animal and plant pathogens, vectors and pests allows for more objective evaluation newly emerging potential threat agents. This method of evaluation can help focus public health activities, agriculture activities related to bioterrorizm detection and response.

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Table 1a. Human pathogens (viruses) assessment according to criteria for selecting pathogens as biological terrorism agents.

	(1) High morbi-dity (++)	(2) High level of mortality/ incapacity (+++)	(3) Stability in the environ-ment (+)	(4) Ease of produc-tion (+)	(5) High level of dissemi-nation (+++)	(6) High poten-cy (+++)	(7) High level of infecti-vity/ intoxi-cation (+++)	(8) No effective prophylaxis and antidotal therapy (+)	(9) Special Public Health preparedness (+++)	(10) Difficulty of detection/ identifi-cation (+)	(11) Public percep-tion (+++)	Total (24)
1. Lassa fever virus	++	+++	+	+	+++	+++	+	+	+++	+	+++	**22**
2. Variola major virus (Smallpox virus)	+	++	+	+	+++	+++	+++	-	+++	+	+++	**21**
3. Ebola virus	++	+++	-	+	+++	+++	+	+	+++	+	+++	**21**
4. Marburg virus	++	+++	-	+	+++	+++	+	+	+++	+	+++	**21**
5. Crimean-Congo hemorrhagic fever virus	++	++	+	+	+++	+++	+	+	+++	+	+++	**21**
6. Machupo virus	++	+++	-	+	+++	+++	+	+	+++	+	+++	**21**
7. Rift Valley fever virus	++	+++	+	+	++	+++	+	-	+++	+	+++	**20**
8. Monkeypox virus	+	++	+	+	+++	+++	++	+	++	+	++	**19**
9. Sin Nombre virus	+	++	+	+	+++	+++	+	+	++	+	+	**19**
10. Junin virus	++	+++	-	-	+++	+++	+	+	++	+	++	**18**
11. Tick-borne encephalitis virus	++	+	+	+	+++	+++	+	-	++	+	++	**17**
12. Eastern equine encephalitis virus	++	+	+	+	+++	+++	+	-	++	+	++	**17**
13. Western equine encephalitis virus	++	+	+	+	+++	+++	+	-	++	+	++	**17**
14. Venezuelan equine encephalitis virus	++	+	+	+	+++	+++	+	-	++	+	+	**16**
15. Yellow fever virus	++	++	-	+	++	++	+	-	++	+	+	**14**
16. Hantaan virus	+	+	-	-	++	++	++	+	**none**	+	+	**11**
17. Nipah virus	+	++	-	-	++	++	-	+	+	+	+	**11**
18. Chikun-Gunya fever virus (CHIK)	+	+	-	+	++	++	-	+	+	+	+	**11**
19. Dengue fever virus	+	+	-	+	++	++	-	+	+	+	+	**11**
20. Omsk fever virus	+	+	-	+	++	++	-	+	+	+	+	**11**

Table 1b. Human pathogens (bacteria, rickettsiae, protozoa and fungi) assessment according to criteria for selecting pathogens as biological terrorism agents.

Disease/*Pathogens*: Bacteria, Rickettsiae, Protozoa, Fungi	(1) High morbidity (++)	(2) High level of mortality/ incapacity (+++)	(3) Stability in the environment (+)	(4) Ease of production (+)	(5) High level of dissemination (+++)	(6) High potency (+++)	(7) High level of infectiousness/ intoxication (+++)	(8) No effective prophylaxis and antidotal therapy (+)	(9) Special Public Health preparedness (+++)	(10) Difficulty of detection/ identification (+)	(11) Public perception (+++)	Total (24)
Bacteria/Rickettsia												
Anthrax (Inhalational)/ ***Bacillus anthracis***	++	+++	+	+	+++	+++	+++	-	+++	-	+++	**22**
Plague (Pneumonic)/*Yersinia pestis*	++	+++	+	+	++	+++	+	-	+++	-	+++	**19**
Tularemia/*Francisella tularensis*	++	++	+	+	++	+++	+	-	+++	-	++	**17**
Typhus exanthematicus/*Rickettsia prowazekii*	++	+++	+	+	++	+++	+	-	++	-	++	**17**
Rocky Mountain Spotted Fever/ *Rickettsia rickettsii*	++	+++	+	+	+++	+++	-	+	++	+	++	**19**
Glanders/*Bulkholderia (Pseudomonas) mallei*	++	+++	+	+	+++	+++	-	+	++	+	+	**18**
Melioidosis/*Bulkholderia (Pseudomonas) pseudomallei*	++	+++	+	+	++	+++	-	+	++	-	+	**16**
Brucellosis/*Brucella melitensis*	+	++	+	+	+++	+++	++	-	++	+	++	**18**
Q-fever/*Coxiella burnetti*	++	+	+	+	+++	+++	++	-	++	+	++	**18**
Brucellosis/*Brucella abortus*	+	+	+	+	+++	+++	++	-	++	-	++	**16**
Brucellosis/*Brucella suis*	+	+	-	+	+++	+++	++	+	++	-	++	**16**
Psitaccosis/*Chlamydia psittaci*	+	+	-	+	+++	++	++	+	++	+	+	**15**
Protozoa												
Primary amoebic meningoencehpalitis/ ***Naegleria fowleri***	+	++	-	+	+	+	+	+	++	+	+	**12**
Granulomatious amoebic encephalitis/ ***Naegleria australiensis***	+	++	-	+	+	+	+	+	++	+	+	**12**
Fungi												
Nocardiosis/*Nocardia asteroides*	++	++	+	+	+	++	+	+	++	+	+	**15**
Coccidioidomicosis/*Coccidioides immitis*	+	++	+	+	+	++	+	+	++	+	+	**14**
Histoplasmosis/*Histoplasma capsulatum*	++	+	+	+	+	++	+	+	++	+	+	**14**

Table 2a. Toxin assessment according to criteria for selecting toxins as terrorism agents.

Toxin	(1) High morbidity (++)	(2) High level of mortality/ incapacity (+++)	(3) Stability in the environment (+)	(4) Ease of production (+)	(5) High level of dissemination (+++)	(6) High potency (+++)	(7) High level of infectiousness/ intoxication (+++)	(8) No effective prophylaxis and antidotal therapy (+)	(9) Special Public Health preparedness (+++)	(10) Difficulty of detection/ identification (+)	(11) Public perception (+++)	Total (24)
1. Botulinum toxin	++	+++	+	+	+++	+++	+++	+	+++	+	+++	24
2. Ricin	++	+++	+	+	+++	++	++	+	+++	+	+++	22
3. Staphylococcal enterotoxin B (SEB)	++	+++	+	+	++	++	+++	+	+++	+	+++	22
4. Shigatoxin	++	+++	+	+	+	++	+++	+	+++	+	+++	21
5. Saxitoxin	++	+++	+	+	++	++	++	+	+++	+	+++	21
6. Abrin	++	++	+	+	+++	++	++	+	+++	+	+++	21
7. Trichotecene Mycotoxins (T2,DON,HT2)	++	++	+	+	+++	+	++	+	+++	+	+++	21
8. Anatoxin A	++	++	-	+	++	++	+++	+	+++	+	+++	20
9. Modeccin	++	+++	+	+	++	+	++	+	+++	+	+++	20
10. Tetrodotoxin	++	++	+	+	++	+	++	+	+++	+	+++	19
11. Centruroides toxin	++	++	+	+	++	+	++	+	+++	+	+++	19
12. Toxin of Clostridium perfrigens	++	+++	-	+	+	++	++	+	+++	+	+++	21
13. Ciguatoxin	++	++	-	-	++	++	++	+	+++	+	+++	19
14. Brevetoxin	++	++	+	-	++	+	++	+	+++	+	+++	19
15. Palytoxin	++	+++	+	-	++	+	++	+	+++	+	+++	19
16. Cyanginosin/Microcystin	++	+++	-	-	++	+	++	+	+++	+	+++	18
17. Batrachotoxin	++	++	-	-	++	++	++	-	++	+	+++	16
18. Bungarotoxin	++	++	-	-	++	++	++	-	++	+	+++	16
19. Aflatoxin	+	+	+	+	+++	+	+	+	++	+	+++	16
20. Viscumin	++	++	+	-	++	+	+	+	++	+	+++	16
21. Verrucologen	++	++	-	-	++	+	+	+	++	+	+++	15
22. Volkensin	++	++	-	-	++	+	+	+	++	+	+++	15

Table 2b. Toxin Risk Assessment (the lower the total number means the more dangerous the toxin as warfare and terrorism agent).

Toxin	(1) Toxicity	(2) Onset	(3) Level of incapacity/mortality	(4) Likely methods of dissemination	(5) Stability in the environment/ storage	(6) Ease of deconta-mination	(7) Ease of production	Total 7-70
1. Botulinum toxin	1	3	7	3	2	6	1	**23**
2. Shigatoxin	1	5	2	3	3	7	2	**23**
3. Staphylococcal enterotoxin B (SEB)	4	6	2	2	3	5	2	**24**
4. Trichotecene Mycotoxin (T2,DON,HT2)	7	4	7	2	1	2	2	**25**
5. Ricin	3	6	8	3	2	5	1	**28**
6. Modeccin	3	6	5	4	5	5	1	**29**
7. Abrin	2	6	5	5	5	5	1	**29**
8. Brevetoxin	6	6	2	4	2	3	8	**31**
9. Aflatoxin	4	8	5	5	5	1	3	**31**
10. Saxitoxin	3	2	8	3	3	7	5	**31**
11. Viscumin	3	6	5	5	6	6	1	**32**
12. Toxin of Cl. perfrigens	3	6	8	3	3	7	3	**33**
13. Centruroides toxin	3	4	6	5	2	5	8	**33**
14. Palytoxin	2	4	8	3	5	3	9	**34**
15. Tetrodotoxin	3	4	5	3	5	5	9	**34**
16. Verrucologen	3	7	6	5	6	6	3	**36**
17. Anatoxin A	5	1	6	7	6	8	3	**36**
18. Cyanginosin/Microcystin	5	2	5	3	7	7	8	**37**
19. Volkensin	4	5	7	6	7	5	4	**38**
20. Batrachotoxin	3	1	6	4	9	8	8	**39**
21. Bungarotoxin	3	4	6	5	8	7	8	**41**
22. Ciguatoxin	3	7	6	6	8	5	9	**44**

Table 3. Animal pathogens assessment according to criteria for selecting pathogens as terrorism and warfare agents.

Animal pathogens	(1) Severe socio-economic/ human health impacts (+)	(2) High morbidity/ mortality rates (+++)	(3) Short incu-bation period (+)	(4) High contagiousness/ transmiss-ibility by contact, respiratory route, or both (+++)	(5) Low infective/ toxic dose (+)	(6) Difficult to diagnose/ identify at an early stage (+)	(7) Stability in the environ-ment (+)	(8) Low effective or cost-effective prophylaxis/ protection/ treatment (+)	(9) Ease of produc-tion (+)	Total (13)
Viruses										
African swine fever virus	+	+++	+	+++	+	+	+	+	+	13
Avian influenza virus (Fowl plague virus)	+	+++	+	+++	+	+	+	+	+	13
Classical swine fever virus (Hog cholera v.)	+	+++	+	+++	+	+	+	+	-	12
Foot and mouth virus	+	+++	+	+++	+	+	+	-	+	12
Rinderpest virus	+	+++	+	+++	+	+	+	-	+	12
Vesicular stomatitis virus	+	+++	+	+++	+	+	+	+	+	13
Newcastle disease virus	+	+++	+	+++	+	+	+	-	+	12
Pest des petits ruminants virus	+	+++	+	+	+	+	+	-	+	10
Nipah swine encephalitis virus	+	++	+	+	+	+	+	+	-	9
Teschen disease virus (Porcine enterovirus type 1)	-	+	+	+	+	+	+	+	+	8
Camel pox virus	-	++	+	+	+	+	+	+	-	8
African horse sickness virus	-	+++	+	+	+	+	-	+	-	8
Blue tongue virus	+	+	+	+	+	+	+	-	-	7
Lumpy skin disease virus	-	+	+	+	+	+	+	+	-	7
Mycoplasmas										
Contagious bovine (pleuropneum.) (M. mycoides var. mycoides type SC) (CBPP)	-	+	-	+	+	+	+	-	+	6
Contagious caprine (pleuropneum.) (M. capriculum var. capri pneumoniae type F38) (CCPP)	-	++	-	+	+	+	+	-	+	7

Table 4. Plant pathogens assessment according to criteria for selecting pathogens as terrorism and warfare agents.

Plant pathogens	(1) Severe socio-economic/ human health impacts (+)	(2) Short incub-ation period (+)	(3) Ease of dissemination (wind, insects, water, etc.) (+++)	(4) Short life cycle (+)	(5) Low infective dose and infectivity (+)	(6) Difficulty diagnose/ identify at an early stage (+)	(7) Stability in the environ-ment (+)	(8) Yield loss (+++)	(9) Cost-effective protection/ treatment (+)	(10) Ease of produc-tion (+)	Total (14)
Fungi											
Colletotrichum coffeanum var. virulans	+	+	+++	+	+	+	+	+++	+	+	**14**
Tilletia indica	+	+	+++	+	+	+	+	+++	-	+	**13**
Puccinia graminis	+	+	+++	+	+	+	+	+++	-	+	**13**
Sclerotinia sclerotiorum	+	+	+++	+	+	+	+	+++	-	+	**13**
Puccinia striiformis (P. glumarum)	-	+	++	+	+	+	+	+	-	+	**9**
Pyricularia oryzae	-	+	++	-	+	+	+	+	-	+	**8**
Ustilago maydis	-	+	++	-	+	+	+	++	-	+	**9**
Dothistroma pini (Scirrhia pini)	-	+	++	-	+	+	+	++	-	-	**8**
Claviceps purpurea	+	+	+++	-	-	+	-	++	-	-	**8**
Peronospora hyoscyami de Bary f.sp. tabacina (Adam) skalicky	-	+	+++	-	-	+	+	+	-	-	**7**
Bacteria											
Xsanthomonas albilineans	+	+	+++	+	+	+	+	+++	+	+	**14**
Erwinia amylovora	+	+	+++	+	+	+	-	+++	-	+	**12**
Ralstonia solanacearum	+	+	++	+	+	+	+	++	+	-	**11**
Xsanthomonas campestris pv. citri	-	+	++	-	+	+	+	++	+	+	**10**
Xsanthomonas campestris pv. oryzae	-	+	++	-	+	+	-	++	+	+	**9**
Viruses											
Sugar cane Fiji disease virus	+	+	++	-	+	+	-	++	-	-	**8**

Table 5. Vectors assessment according to criteria for selecting as terrorism and warfare agents.

Vectors	Order	Class	Biological Agent	Disease	(1) Weapo-nized (+)	(2) Significant impact on human health or animal resources (+)	(3) Short life cycle (+)	(4) Ease of produc-tion (+)	(5) Resistance to insecticides or bio control agents (+)	(6) Ease of dissemi-nation (+)	Total (6)
Xenopsylla spp. Ctenocephalis spp. Leptopsilla spp.	Siphonoptera	Insecta	Yersisnia pestis	Plague	+	+	+	+	+	+	6
Ixodides Hyalomma marginatum Hyalomma Anatolicum Anatolicum	Acari	Arachnida	Arbovirus	Crimean-Congo hamorhagic fever (CHF)	+	+	+	+	+	+	6
Mansonia spp. Culex spp. Culiseta spp.	Diptera	Insecta	Arbovirus	Easzern Equine Encephalitis	+	+	+	+	+	+	6
Pediculus humanus	Anopluraa	Insect	Rickettsia prowasekii	Typhus exanthematicus	+	+	+	+	+	+	6
Ixodides Dermacentor spp. Rhipicephalus spp. Amblyomma spp.	Acari	Arachnida	Francisella tularensis	Tularemia	+	+	+	+	+	+	6
Dermacentor andersoni	Acari	Arachnida	Coxiella burnetti	Q-Fever	-	+	+	+	+	+	5
Dermacentor andersoni Dermacentor varabilis Amblyimma Cajennese Rhipicephalus sanguineus	Acari	Arachnida	Rickettsia rickettsii	Rocky Mountain Spoted Fever	-	+	+	+	+	+	5

Table 6. Pests assessment according to criteria for selecting as terrorism and warfare agents.

Pests	Order	Common Names	Host	(1) Weapo-nized (+)	(2) Severe socio-economic/signi-ficant adverse effect to plants (+)	(3) Ease of production (+)	(4) Short life cycle (+)	(5) Resistance to pesticides (+)	(6) High reprodu-cibility (+)	(7) Ease of dissemi-nation (+)	Total (7)
Dociostaurus maroccanus	Orthoptera	Grasshoppers Crickets Cockroaches	Plants	-	+	+	+	+	+	+	6
- Haplothrips Tritici - Thrips Tabaci	Thysanoptera	Thrips	- Wheat, mais - Tabacco, tomato	-	+	+	+	+	+	+	6
- Eurygaster integriceps - Lygus linecularus - Acrosternum milleri	Hemiptera	Bugs	- Wheat - Pistachio - Pistachio	-	+	+	+	+	+	+	6
- Chilo suppressalis - Cirphis unipunctata - Earias insulana	Lepidoptera	Batterflies Moths Skippers	- Rice - Rice, mais - Cotton	-	+	+	+	+	+	+	6
Leptinotarsa decemlineata (Colorado potato beetle)	Coloptera	Beetles Weevils	Potatoes		+	+	+	+	+	+	6
Harmolita tritici	Hymenoptera	Ants Bees Wasps	Wheat	-	+	+	+	+	+	+	6
Phytophaya destructor	Diptera	Flies	Wheat (Barleiy) Oats	-	+	+	+	+	+	+	6
Terranychus takestani	Tetranychidae	Mites	Plants	-	+	+	+	+	+	+	6
Cenopalpus spp.	Errophyoidae	Mites	Fruit trees	-	+	+	+	+	+	+	
Diabrotica virgifera virgifera	Chrysomelidae	Western corn rootworm	Maize	-	+	+	+	+	+	+	6